

## **Automated, Miniaturized Instrument for Measuring Gene Expression in Space**

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To facilitate astrobiological studies on the survival and adaptation of microorganisms and mixed microbial cultures to space environment, we have been developing a fully automated, miniaturized system for measuring their gene expression on small spacecraft. This low-cost, multi-purpose instrument represents a major scientific and technological advancement in our ability to study the impact of the space environment on biological systems by providing data on cellular metabolism and regulation orders of magnitude richer than what is currently available. The system supports growth of the organism, lyse it to release the expressed RNA, label the RNA, read the expression levels of a large number of genes by microarray analysis of labeled RNA and transmit the measurements to Earth. To measure gene expression we use microarray technology developed by CombiMatrix, which is based on electrochemical reactions on arrays of electrodes on a semiconductor substrate. Since the electrical integrity of the microarray remains intact after probe synthesis, the circuitry can be employed to sense nucleic acid binding at each electrode. CombiMatrix arrays can be sectorized to allow multiple samples per chip. In addition, a single array can be used for several assays. The array has been integrated into an automated microfluidic cartridge that uses flexible reagent blisters and pinch pumping to move liquid reagents between chambers.

The proposed instrument will help to understand adaptation of terrestrial life to conditions beyond the planet of origin, identify deleterious effects of the space environment, develop effective countermeasures against these effects, and test our ability to sustain and grow in space organisms that can be used for life support and *in situ* resource utilization during long-duration space exploration. The instrument is suitable for small satellite platforms, which provide frequent, low cost access to space. It can be also used on any other platform in space, including the ISS. It can be replicated and used with only small modifications in multiple biological experiments with a broad range of goals in mind.